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[US/US]; 1120 Fairview Drive, Lapeer, Michigan 48446  
(US).

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(74) Agent: **WILLIS, Reid, S.**; The Dow Chemical Company,  
Intellectual Property, P.O. Box 1967, Midland, MI 48641-  
1967 (US).

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(71) Applicant (*for all designated States except US*): **DOW  
GLOBAL TECHNOLOGIES INC.** [US/US]; Washing-  
ton Street, 1790 Building, Midland, MI 48674 (US).

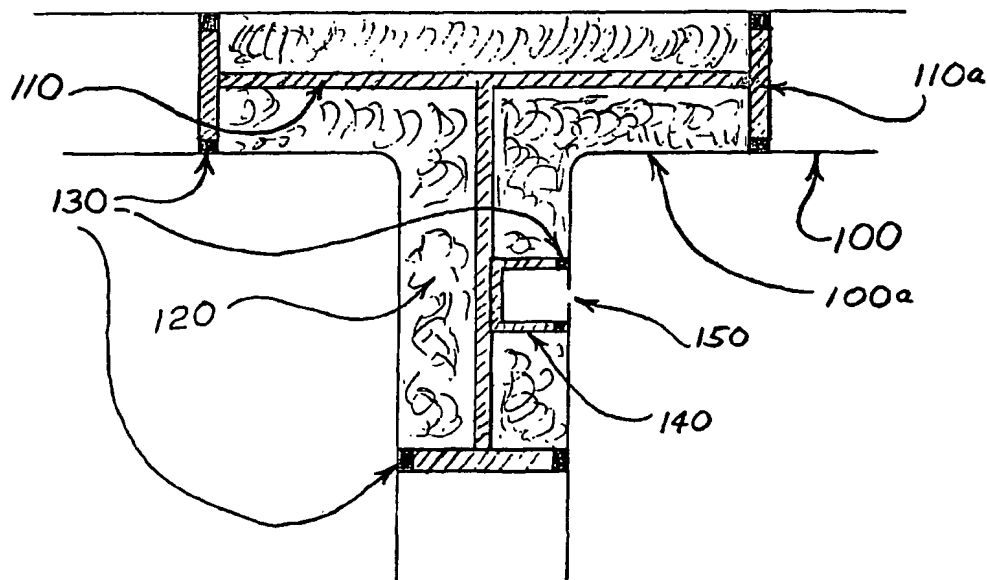
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(72) Inventor; and

(75) Inventor/Applicant (*for US only*): **KROPFELD, Scott**

[Continued on next page]

(54) Title: **REINFORCED STRUCTURAL BODY AND MANUFACTURING METHOD THEREFOR**



(57) Abstract: The present invention describes a hollow structural body such as an automotive unibody or frame rail that is reinforced with a reinforcing material such as a polyurethane foam by inserting into a portion of the structural body a bulkhead-containing insert, which, in combination with the structural body at the place of insertion, creates a containment region for the reinforcing material. Uncured reinforcing material can then be added to the containment region and cured. The present invention solves a problem in the art by providing structural reinforcement to be easily and precisely placed within the structural body to provide, for example, enhanced crash resistance or improvements in acoustical properties.

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**REINFORCED STRUCTURAL BODY AND MANUFACTURING METHOD THEREOF**

The invention relates to a structural body containing a structural reinforcing material. In particular the invention relates to reinforced structural, sealing, and acoustical vehicular bodies such as reinforced frame rails and unibodies.

A hollow member (structural body) of a vehicle is often filled with foam to seal, dampen noise, and to impart structural strength and rigidity or acoustical properties. Typically, a structural body is filled with a foam such as polyurethane by introducing fluid reactants into a region that it is desired to reinforce (that is, a reinforcing region) and allowing the foam to react and fill the reinforcing region. Unfortunately, this method is uncontrolled and the foam inconsistently fills the cavity from one vehicle to the next. The method, in many instances, also requires the use of specialized plugs to keep the foam from escaping and clogging up functional holes such as mounting holes for other components.

U.S. Patents 5,194,199, 5,866,052 and 6,062,624 disclose yet another way of reinforcing structural bodies by inserting a pre-formed cured structural foam part into the structural body. However, this approach relies on the use of an expandable polyurethane or epoxy resin to adhere the structural part into place, which resin detracts from the overall structural performance of the part. Furthermore, the integrity of the structural part-structural body bond can be compromised due to the inconsistency of the bake ovens used to cure the adhesive. Accordingly, it would be desirable to provide a structural reinforcement to be precisely placed within a structural body that is not subject to the deficiencies of a sealant

or that relies upon consistencies of bake oven temperatures.

The present invention solves a problem in the art by providing a method for reinforcing a structural body

5 having a cavity comprising the steps of a) inserting into a portion of the cavity of the structural body a bulkhead-containing insert which, in combination with the structural body at the place of insertion, forms a containment region for a reinforcing material, which

10 containment region has an inlet; b) sealing the insert to the structural body; c) adding through the inlet of the reinforcing region a sufficient quantity of an uncured reinforcing material to at least partially fill the containment region; and d) curing the reinforcing

15 material.

In a second aspect the present invention is a reinforced structural body comprising a) a structural body having a cavity b) a bulkhead-containing insert disposed and sealed within the cavity, which insert, in combination

20 with the structural body at the place of insertion, defines a reinforcing region that is at least partially filled with an uncured reinforcing material.

In a third aspect the present invention is a reinforced structural body comprising a) a structural body

25 having a cavity b) a bulkhead-containing insert disposed and sealed within the cavity, which insert, in combination with the structural body at the place of insertion, defines a reinforcing region that is at least partially filled with a cured reinforcing material.

30 The present invention is particularly useful in reinforcing a structural body, particularly of a vehicular frame rail or unibody. For example, it is quite common

for frame rails of automobiles to have sections that are weakened to create crush zones to dissipate the energy of an accident and protect the occupants. The frame rails also support parts of the automobile such as the  
5 transmission. The present invention provides a way for a reinforcing material to be introduced selectively into a portion of the frame rail without compromising the crush zone or clogging the mounting holes for other components such as engines and transmission. The present invention  
10 may also be used to reinforce other components of a vehicle such as rocker panels, beams, pillars, crossbars, body mounts. Furthermore, the present invention may be used for non-vehicular applications such as athletic equipment (for example, golf clubs), boats, bicycles,  
15 aircraft, trucks and trains.

Fig. 1 is a perspective view of an automotive unibody fitted with a reinforcing part.

Fig. 2 is an enlarged cutaway view of the reinforcing part depicted in Fig. 1.

20 Fig. 1 illustrates an example of a preferred embodiment of the present invention. Structural body 100 is in the form of an automotive unibody for illustrative purposes. Inserted and positioned within a portion of the cavity of the unibody 100 using, for example, mounting  
25 tabs, clips, screws, rivets, alignment pins, welds, or glue, is a bulkhead-containing insert 110 that is placed in the region to be reinforced. The insert 110, in combination with a portion of the inner wall of the structural body at the place of insertion 100a, confines  
30 subsequently injected reinforcing material to the region defined by the insert and the portion of the structural body at the place of insertion. Thus, the insert 110, by

itself, is not a container, but rather forms a reinforcing region for subsequently introduced reinforcing material in combination with the structural body by virtue of the presence of a) at least one bulkhead 110a associated with the insert and b) the inner wall of the structural body 100a within the confines of the at least one bulkhead 110a. (An insert with a single bulkhead may be appropriate where the place of insertion includes a pre-existing bulkhead.)

10       The reinforcing region is at least partially filled, more preferably substantially completely filled, with a reinforcing material 120, which is preferably a 2-part expandable foam such as an expandable polyurethane or an expandable epoxy resin.

15       Turning now to Fig. 2, which is an enlarged cutaway view of the insert 110 within a portion of the unibody 100, the insert 110 is advantageously sealed to the unibody with a sealant 130. Also depicted is a protuberance 140 extending in the direction of the reinforcing material 120. The protuberance 140, which can be made by any suitable method such as surface deforming or capping a hole, protects an opening 150, typically a mounting hole or access hole, from being clogged with reinforcing material 120.

25       The structural body 100 can be made using any suitable material, the selection of which is application dependent. For example, for a frame rail or other tubular structural member of an automobile, the structural body is advantageously formed of metal such as steel or aluminum or alloys thereof. Other suitable materials may be plastics, wood, ceramics, composites, glass and other materials rigid enough to form the structural body.

The insert 110 may be fabricated using any suitable material such as those used to make the structural body 100, although the insert 110 and structural body 100 need not be made with the same materials. For example, if the structural body 100 is a steel unibody, the insert 110 is preferably a plastic or filler reinforced plastic that can withstand the temperatures and stresses associated with manufacturing an automobile. Examples of suitable plastics for such an application include nylon, polycarbonates, polystyrenes, polyolefins such as polyethylene and polypropylene, a thermosetting resin such as phenol-formaldehyde, phenol furfural, polyurethanes, and epoxy resins. Preferably the plastic is a filler reinforced thermoplastic material such as a glass reinforced nylon, commercially available as VYDYNE<sup>®</sup> reinforced nylon, (a trademark of The Dow Chemical Company). Preferably the glass reinforced nylon has a volume to volume glass content of from 10 percent to 40 percent.

The sealant 130 is preferably a low density heat expandable epoxy sealer such as BETABRACE<sup>®</sup> epoxy resin (a trademark of The Dow Chemical Company). However, sealing can also be accomplished by using a non-expanding sealer. Moreover, sealing can also be accomplished mechanically, for example, by using an elastomeric insert that conforms closely to the contours of the unibody at the place of installation.

The reinforcing material 120 may be any material that enhances structural or acoustical properties of the structural body 100. Examples of preferred materials include foams such as expanded polyurethane and expanded epoxy resin. Preferably, the reinforcing material 120 is a polyurethane foam formed by a suitable method such as

those known in the art. For example, the polyurethane foam may be made by any of the methods described in U.S. Patents 4,390,645; 2,866,744; 3,755,212; 3,849,146; 3,821,130 and 5,968,995.

5       A preferred method of preparing a reinforced structural body includes the steps of inserting into a portion of the cavity of the structural body and affixing thereto a bulkhead-containing insert which, in combination with the structural body at the place of insertion,  
10       creates a reinforcing region. For the purposes of this invention, a reinforcing region is a cavity that defines the region that it is desired to reinforce.

      The affixed insert is then heat sealed to the structural body to confine the reinforcing material within  
15       the reinforcing region. The reinforcing material, preferably an uncured 2-part polyurethane resin, is then added to the reinforcing region through an inlet, which can either be pre-existing or created, to at least partially fill, more preferably to substantially  
20       completely fill the reinforcing region. The reinforcing material is then cured, preferably chemically or by heating, more preferably chemically.

      The insert may be prepared by a variety of techniques including injection molding, blow molding, and stamping,  
25       with injection molding being preferred. The insert is preferably injection molded into opposing and connectable halves that are snapped together and then affixed into the structural body.

      The following example is for illustrative purposes  
30       only and is not intended to limit the scope of the invention.



EXAMPLES

## Example 1

A VYDYNE 30 percent volume-to-volume glass filled nylon 66 insert is inserted and held mechanically into a first frame rail half with a clip using a locating hole in the first frame rail half. The insert, which is coated with a 2-mm coating BETABRACE 85076 expandable epoxy foam adhesive, is designed to maximize the amount of foam that contacts the frame rail directly.

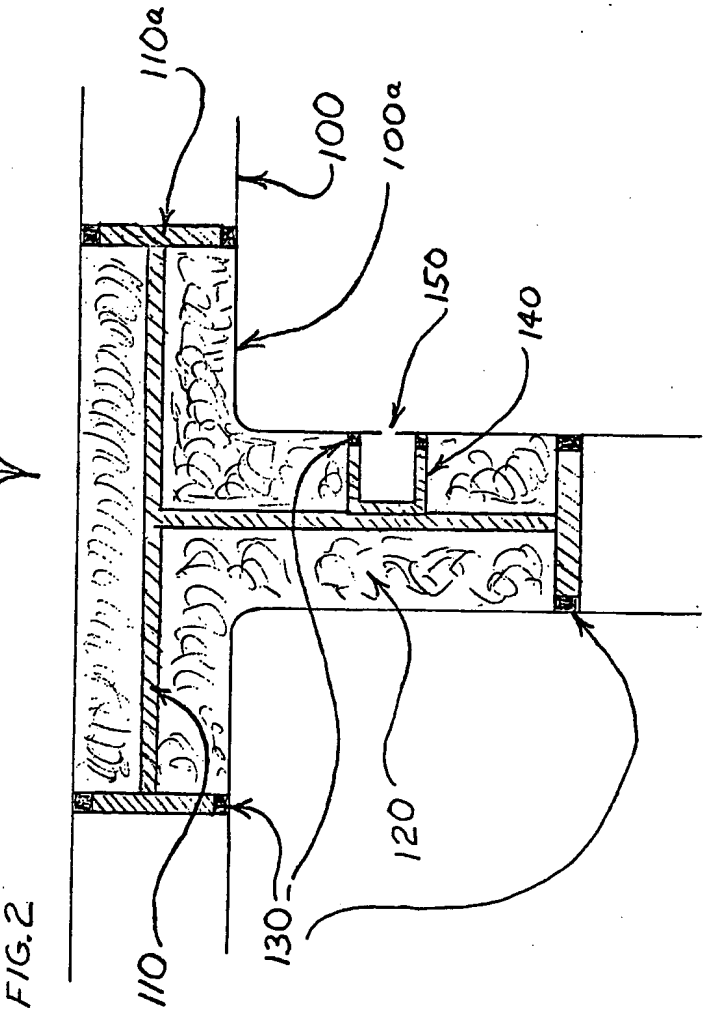
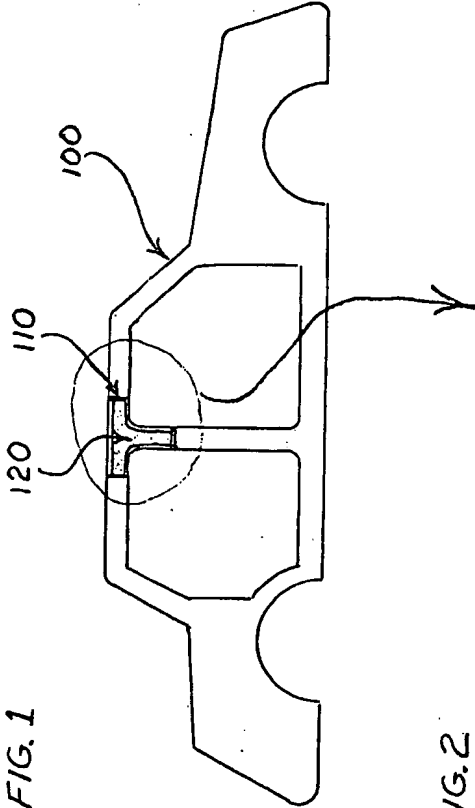
A second frame rail half is then welded to the first frame rail half. The welded frame rail is then e-coated and the e-coat liquids flow freely through all the cavities within frame rail. The welded frame rail is then baked to a temperature sufficient to cure the e-coating and to seal the insert together with the frame rail by way of the concomitantly cured resin.

BETAFOAM 88100 isocyanate and BETAFOAM 88124 resin are injected into the inner cavity and allowed to cure forming a frame rail having reinforcing solely within the confines of the insert and the portion of the frame to which it is inserted.

WHAT IS CLAIMED IS:

1.                   A method for reinforcing a structural body having a cavity comprising the steps of a) inserting into a portion of the cavity of the structural body a  
5       bulkhead-forming insert which, in combination with the structural body at the place of insertion, forms a containment region for a reinforcing material, which containment region has an inlet; b) sealing the insert to the structural body; c) adding through the  
10       inlet of the reinforcing region a sufficient quantity of an uncured reinforcing material to at least partially fill the containment region; and d) curing the reinforcing material.
2.                   The method of Claim 1 wherein the  
15       structural body is an automotive frame rail or unibody.
3.                   The method of either of Claims 1 of 2 wherein the uncured reinforcing material is an expandable 2-part polyurethane resin or an expandable  
20       2-part epoxy resin.
4.                   The method of Claim 3 wherein the uncured reinforcing material is an expandable 2-part polyurethane resin.
5.                   The method of any of Claims 1 to 4 wherein  
25       the insert is heat sealed to the structural body by way of a heat activated expandable epoxy adhesive or a heat activated non-expandable silicone or acrylic adhesive or by mechanical means.

6. The method of any of Claims 1 to 5 wherein the reinforcing material substantially fills the containment region.
7. A reinforced structural body comprising a)  
5 an automotive frame rail or unibody having a cavity  
b) a bulkhead-forming insert disposed and sealed within the cavity, which insert, in combination with the structural body at the place of insertion, defines a reinforcing region that is at least  
10 partially filled with a reinforcing material.
8. The reinforced structural body of Claim 7 wherein the reinforcing material is an expandable 2-part polyurethane or a cured expanded 2-part polyurethane.
- 15 9. The reinforced structural body of either of Claims 7 or 8 which is sealed by way of an expanded epoxy adhesive.
10. The reinforced structural body of any of Claims 7-9 wherein the reinforcing material  
20 substantially fills the reinforcing region and wherein the insert is a filler reinforced thermoplastic that includes a protuberance projecting in the direction of the uncured reinforcing material.



## INTERNATIONAL SEARCH REPORT

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 PCT/US 03/01303

## A. CLASSIFICATION OF SUBJECT MATTER

 IPC 7    B29C33/00    B29C67/24    B29C44/18    B62D29/00    //B29K63:00,  
 B29K75:00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7    B29C    B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

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 European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
 Fax: (+31-70) 340-3016

Authorized officer

Van Nieuwenhuize, O

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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